Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

BIRDS: THE POLICE OF THE AIR

Although in the literature and in the daily life of the ancients, birds of all kinds played no inconsiderable part, either as symbolic of virtues and blessings, like the eagle and the dove, or as omens of coming disaster, like the raven and the owl; and though in the Mosaic law the Jews were permitted to gather the young birds (squabs), but were charged to leave alone the dam (*Deut.* xxii, 6-7), there was never until our own day any proper conception of the economic importance of birds to human life and happiness. Indeed, the science of ornithology is one of the newest, and except by the few that have devoted years of study to it, its practical value has been little understood or appreciated' until within the past twenty-five years.

It is true that Wilson, the peerless Audubon, Bonaparte, Cassin, Bachman, and others more or less brilliant had, after years of patient, devoted study, given to the world detailed knowledge of birds and their habits. But the proper method lay yet undiscovered, and it was not until Baird's great work in 1858 that ornithology began to develop a more scientific nomenclature and a truer classification of the various species. After the Civil War scientific investigations began to be made on the bird itself by measuring bones, bills, claws, feathers, and by examining stomachs to determine the nature of the food. The study of insects had already received a new impetus from the work of Riley, Forbes, Comstock, and others,— a work made painfully necessary by the enormous ravages of crops by insect pests, especially in the West and Middle West,—and an investigation of the great locust plague in Kansas and adjoining States (1874-1877) first settled in the minds of entomologists the question of the relations of birds to the agriculture of the country and of the world. Their conclusions were that man's life in the world is absolutely dependent on the work done by birds in checking the growth of injurious insects, and that, were this check removed, the world would become a desert within half a dozen years. Later investigations have added confirmation at each step and the conclusion has never been seriously assailed.

Having thus had forced upon the country the absolute necessity for scientific investigations along these lines, the United States Government in 1885 established the Biological Survey at Washington, with Dr. C. Hart Merriam as director, and this branch has grown into one of the leading divisions of the National Department of Agriculture. Though, as its name implies, its business is to study the life forms of the continent, its principal work is the study of birds in their relation to agriculture. One man, Dr. F. E. L. Beal, the leading investigator, has examined the stomachs of more than fifty thousand birds. Occupying the lower floor of the same building, the Bureau of Entomology, under Dr. L. O. Howard, supplies the correlate work on insects. Across the way, the Bureau of Plant Industry attends to the examination of seeds and other matters belonging to the domain of botany.

Of this Biological Survey the militant arm is the National Association of Audubon Societies, with headquarters at 14 Broadway, New York City, and branch societies all over America. There are off-shoots of the society, with different names, in every civilized country. Among the most notable is The Royal Society for the Protection of Birds, in Great Britain, with the Duchess of Portland at its head, and conspicuous among its members is our old friend, Sir John Lubbock, now Lord Avebury, whose books, *The Pleasures of Life* and *Ants, Bees and Wasps*, are familiar enough to every college boy. This, in brief, is the machinery for the study and for the protection of birds, to which should be added the great museums: the British Museum, the German museums, the New National and the Smithsonian in this country, and others well known abroad and at home.

After this hasty and imperfect sketch of the historical development of the subject, one is naturally led to ask, what place is assigned to the bird in the order of vertebrates? Avoiding, as far as possible, scientific nomenclature, a bird comes of an order, *Aves* (*Sauropida*, or reptile-like forms), situated between reptiles, with which they had common origin, and mammals. Like reptiles, birds lay eggs and these eggs hatch outside the body; like reptiles, they have no diaphragm, such as is found in mammals. One animal, the platypus of Australia, lays eggs, but otherwise is not closely related to birds. Birds differ radically from reptiles and animals in being covered with a tegumentary outgrowth known as feathers; and in flying by means of such outgrowth, they are again distinct, for bats, other flying animals, and flying reptiles, fly by means of tegumentary expansion, not by means of an outgrowth. The bat's phalanges are simply webbed, as are the fins of flying fish and the feet of flying squirrels and flying lemurs. There are other sharply distinguished minor differences, but it would tax the patience of the reader to enter into them here and serve no useful purpose in elucidating the work of birds in policing the air.

It must be noticed, however, that birds are warm-blooded, the temperature frequently going as high as 112 degrees F. There are four chambers to the heart and the circulation is double. There is but one aortic arch (the right), and but one pulmonary artery springs from the heart. The lungs are in the thoracic cavity and are moulded to its walls. In mammals the lungs are encased in a sac (the pleuron). A singular part of the bird's anatomy is the fact that the aorta passes to the right of the wind-pipe, whereas in mammals it passes to the left. Many of the bird's bones are hollow, admitting the passage of air, and if the humerus be pierced or broken so as to leave a vent, the bird cannot be strangled by compressing the windpipe.

All flying birds have a sharp breast-bone (sternum) and they are said to be carinate or keel-shaped, whereas flightless birds have a flattened breast-bone (*ratitate*, or raft-shaped) as noted in the Struthionidæ, or Ostrich family, the Emus, the Cassowary, the three-toed Rhea (the African Ostrich has two toes, one large the other small) of South America, the penguin of the Antarctic solitudes, and the flightless divers of our own shores.

The sight of the bird is the keenest among all living creatures, and as a class they rule the air by being able to pass in a few hours across states and even wide continents. Owing to the high temperature and the special conformation of their bodies, their digestion is marvelously rapid. It requires only about two hours for crows and similar birds to empty their stomachs and get ready for another gorge, so that a healthy crow would need not less than eight gorgings during an ordinary summer day. In addition to this, many birds regurgitate, and in 1848 Franklin's gulls were often seen to vomit up crickets in order to gorge themselves again. The regurgitation of owls and hawks is well known, and a study of the thrush family and many others shows the same trait, when the shells, legs and harder parts of insects are habitually vomited up, the softer parts passing through the cloaca and out at the vent.

Taking these facts in connection with the universal distribution of birds,—for they sweep mountain ranges, forests, deserts, and the most desolate reaches of the seas,—their work as a great air-police can be readily understood and appreciated. Moreover, each individual species of bird is wonderfully adapted to the work they have to do. The long, slender bills of the worm-eating birds, the short, heavy bills of the seed eaters, the chisel-like bills of woodpeckers and their allies, the nuthatches, the talons of birds of prey (the Raptores), the webbed feet of swimmers and divers, the lobed foot of the coot, the long toes of the jacana, enabling its possessor to run across lily-pads, the tongue provided with a sticky secretion, as in the yellowhammer or flicker, for holding ants [he can eat five thousand at a single meal], and the dainty probe of the hummers for insertion into flower-cups where corroding insects are destroying blooms, all these are obvious examples of adaptation of form to function.

The migration of birds, one of the miracles of nature annually unfolded, furnishes another illustration of the wonderful adaptive powers of the birds. No animal could withstand the rapid changes of climate in an open air journey over half the earth's surface, following the north and south direction. In fact, an animal could hardly survive the changes to which an ordinary turkey vulture is subjected when, rising from the heated earth in summer, he goes to an elevation of four or five miles, where the temperature is similar to that of the Arctic regions. Yet the bird undergoes these changes within an hour. Covered with feathers, soft, downy, non-conductors of heat, and provided inside with a great air-cushion formed of hollow bones and similar contrivances, he is enabled to withstand readily any sudden and great change of temperature. It is well known to sportsmen that a wild bird can not be frozen, if water and food are accessible, even with the thermometer ranging out of sight below zero.

As no bird hibernates, and as many breed in regions where they would perish of cold, migration is a necessity for certain birds. In the tropics, to which the great majority of birds migrate, they know by instinct when the wet season is about to arrive, during which the insect host hide themselves away in cracks and crannies impossible to get at. And these migratory birds come to us just when millions of insects are beginning their destructive work on gardens, lawns, orchards, forests, and fields, and immediately fall to devouring these pests. Even the helpless young of seed-eating birds must have insect diet during their adolescence.

Some birds, the golden plover, the Bartramian sandpiper, and others, make a migration exceeding sixteen thousand miles, according to the route travelled. For example, the golden plover breeds on the shore of the Arctic ocean. After the young are reared, the older birds go to Labrador, and feed on a berry known as the curlew berry, which stains their flesh black. They proceed to New Foundland and make out to sea, flying out of sight of land; then they turn at right angles, go due south for eight hundred miles, and sight the Bermudas. Unless foul weather is encountered, the birds do not stop at the Bermudas, but rest on a wave, when tired, and continue their journey, sighting the next land at Barbadoes, on the outer rim of the Caribbean sea. Nor do they stop there, unless weather conditions make it nceessary, but go straight ahead, across the Guianas, past the selvas of the Amazons, across the mighty Rio de la Plata until they alight on the shores of Patagonia. The next spring, on the return migration, the plovers cross the Andes, come up the western slope of South America, arriving the same day in Guatemala and in Texas, during the month of March. After resting and feeding, the plovers go north to the rim of the Arctic and lay their eggs — completing in all a journey which requires sixteen thousand miles of travel. The Bartramian sandpiper, known variously as the "Upland Plover," the "Grass

Plover," the "Prairie Pigeon," and in Louisiana as the "Papebotte," sometimes strays to Australia, to South Africa, and to Europe, before returning home.

In order fully to understand the important function of birds in destroying insect pests and checking their ravages, a few words are necessary just here on the nature of insect life and on the extent of damage wrought and threatened by the marvelous increase in crop pests within the last few years. The creepy feeling of horror that the ignorant feel at the touch of the caterpillar or at sight of maggots working in decayed flesh, finds justification in the deliberate conclusions of science. Huxley estimated that the *Phylloxera vastata*, which has wrought such enormous damage to grapes in Europe, would, if unrestricted, increase so much in one year that they would equal in bulk five hundred million human beings. The Colorado potato beetle, with his sixty million annual progeny, seems nothing to the house-fly with his two and one-half billion, and the house-fly fades into insignificance when compared with the hop vine aphid (*Phorodon humuli*). This aphid produces thirteen generations in a single year, and if all the lice came to maturity and produced offspring, the number in the twelfth generation alone would equal ten sextillions; or, to convey the idea graphically, if they were extended in line, ten to the inch, they would reach the sun and beyond it to the nearest fixed star, and again beyond that to the most distant fixed star that the most powerful telescope ever invented brings to our view, so distant that light, travelling at the rate of 180,000 miles per second, would take twenty-five years to reach it. There are more than a million species of insects known to science, and the unchecked increase of any one of a thousand species of insects would make desert our earth within a decade.

From the moment man began his life on earth until the present hour, he has had to wage war with insects in order to maintain a bare existence. At first the balance lay in man's favor, for there was little tillage; dense forests stretched away on every hand, affording food and shelter to endless birds; insect food was scarce, and from the insect's point of view inferior. But the cultivation of ever more territory wiped out thousands of miles of forests and provided a succession of tender and succulent crops, the choicest insect food. With the improvement of fire-arms and other modes of destroying birds, there ensued a destruction of the world's avifauna, unapproached since time began. The trade in feathers is even now taking toll of the birds to the extent of three hundred and fifty million annually. When it is remembered that such birds are taken only at nesting time because of the nuptial moult, or bridal dress, of the birds, and that the helpless young must perish, the enormity and iniquity of the feather trade become apparent.

As a result of this wholesale, wanton destruction of our police of the air, the annual loss inflicted by insects on the crops, forests, orchards, and gardens of the United States has been mounting higher with each year. In 1864 it exceeded three hundred million dollars; in 1904 it was within a fraction of eight hundred million dollars. Last year it exceeded a billion dollars, or more than three times the cost of the War between the States that drenched a continent in blood. The best estimates place the number of our birds at less than forty per cent of the number we had twenty years ago. Thus, as the birds decrease, the insects increase and multiply with alarming rapidity.

Still another point is to be noted. The enormous capacity which an insect, especially a larva or caterpillar, has for devouring food, almost passes belief, but it has been subjected to rigid investigation and the following facts have been proved beyond dispute. Trouvelot found that a silkworm will devour eighty thousand times its own weight in the fifty-six days it requires to arrive at maturity. This is about the average amount of food consumed by a caterpillar. In two weeks the Rocky Mountain locust (*Melanoplus spretus*) covered a thousand miles in 1877, made the country a desert, produced a famine among the people and the death of all their stock and cattle on the ranges. The United States army was mobilized as for a foreign invasion and sent West to relieve the famine and to check the wholesale emigration of the people. In 1881 a line of army worms (*Heliophilæ unipunctæ*) crossed the State of Alabama. It was forty-four miles long and in places six hundred yards wide, and often the worms were piled as high as a man's head. The Chalcis flies checked this march by parasitizing the caterpillars,— that is to say, by laying eggs inside the bodies of the caterpillars through a sharp ovidepositor. On the hatching of the eggs into maggots the caterpillars were destroyed within two days. Massachusetts has had to spend two and one-half million dollars out of the public treasury in a fight against the imported Gypsy moth, and the war goes merrily on, with no end in sight. These examples could be multiplied indefinitely, but enough has been written to show the appalling danger to human life from insects, which have been a menace from the time that the locusts brought royal Pharoah to his knees, in the old days of Egypt, until the present period.

In conclusion, something should be said of the life history and development of insects in general in order to illustrate the effectiveness of birds in checking them. As every student knows, the insect has four forms, in its regular metamorphosis. First is the egg; second, comes the larva, or creeping form, such as the common caterpillar. The third form is the pupid or chrysalid, encased in a cocoon or case, in which many insects winter. When this case breaks open, the full grown insect, or imago, emerges. There are also incomplete forms, such for example, as the grasshopper, which is the locust of history, in which three forms appear. A wingless grasshopper is hatched from the egg. With the coming of wings there is an adult grasshopper. The wingless form in this metamorphosis is known as a nymph.

Now, numbers of small birds,— the brown creeper, seen often going slowly up the tree trunks until he reaches some thirty or forty feet from the ground, when he drops to the foot of the next tree; the black-capped chickadee, the acrobat of the bird kingdom, that hangs by one foot, preens himself in this position and sometimes turns somersaults over the twigs; the nuthatches that run down the tree trunks; and millions of warblers in spring,— all eat vast quantities of insects' eggs. From four thousand to six thousand eggs have been taken from the stomach of one of these birds. The small birds eat also countless millions of newly hatched caterpillars, which are then very minute. The huge tomato worm that affrights the soul of the small boy is hardly half the size of a cambric needle when he is first hatched and easily falls a victim to Jenny Wren. The larger caterpillars are devoured by larger birds, jays, cuckoos, hawks, owls, and the like. In winter, robins and other thrushes tear open the pupæ and devour the insect inside, and when at last the adult,— moth, butterfly, or beetle,—emerges and takes flight into the new world, the chances of his being devoured by nighthawks, flycatchers, or red-headed woodpeckers by day, or by screech owls or chuck-wills-widows by night, are very good indeed. Meadow larks and grackles bore in the ground for white grubs, cutworms, wireworms, and other farm pests that dwell there, destroying plant roots. Woodpeckers drill into the bark, transfix the grub that is destroying the tender inner bark, or cambium, and cut short his career, thus saving thousands of trees. Small birds pick off the scale from fruit trees or devour plant lice. The Hawk, Owl, and Eagle tribe (the Raptores) keep a salutary check on the spread of rodents, such as rats, mice, rabbits, and the like. The conditions when such a check is wanting may be plainly seen in Australia, where the whole power of the government has not been able to check the spread of rabbits, except by building hundreds of miles of woven wire fences to keep them out. Besides these, the sea birds act as scavengers of the shore line of the world and keep it clean, eating up the dead bodies that float seaward from the rivers of a continent, the refuse of cities and ships, which would pollute the shore waters and render life unsafe to coast dwellers.

Out of millions of known instances, these few examples are enough to make the thoughtful pause and the careless think. So continued has been the destruction of our avifauna, along with other natural resources and safe-guards, that the danger line has been reached. It will require all the force of American manhood to stem the tide and to save the heritage of freedom. The physical danger is great and ominously menacing. It seems, however, that we should need no "hangman's whip" to hold us in order. The pleasure we derive from watching the birds, their swift and silent movements during migration through two continents, their bright plumage and cheerful songs in the springtime of the year, all suggestive of the loving care which, mindful of our needs, made them for our use, and of old set metes and bounds through changing æons,— all this ought to fill us with reverential awe, and fire our hearts to do a man's part ere we "go the way of all the earth."

JAMES HENRY RICE, JR.

Columbia, South Carolina.